



## Message from Philippe Berterottière, GTT Chairman and CEO

### GTT to up-date industry at Gastech on its latest innovations

Welcome to this special Gastech edition of GTT Inside. In this issue, we will give you a taste on the innovations GTT will be showcasing in Tokyo.

The highlight will be the official launching of a membrane technology dedicated to the transport of LPG and other similar liquid gases. GTT MARS™ has been developed based on our traditional sea-proven technologies to transport liquids at -55°C or above with densities up to 700 kg/m<sup>3</sup>. The industrialisation of our latest NO and Mark evolutions is now advanced and the first order for a Mark V vessel has been confirmed in December

last year. The Mark V and NO96 MAX designs advance further the boil-off reduction of the GTT containment systems as well as their strength for new applications (flexibility in filling levels, FSRU, FLNG, small scale and LNG as a fuel applications).

Details of our on-board boil-off optimisation software and an innovative gravity based storage system are also introduced.

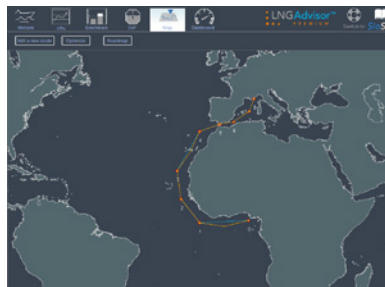
Some highlights from 2016: the first FLNG built by DSME for Petronas has been delivered, GTT is inside. Also, the very first multigas carriers built by SHI for MOL and Reliance have been delivered. They are capable of transporting any kind of liquid gas. GTT is inside.

We look forward to exchanging with you further in Tokyo on these topics.

*Philippe Berterottière - Chairman and CEO*

## SERVICES / LNG Advisor Premium

### An operational solution to minimize BOR on LNGCs



Boil-off gas (BOG) consumption is the second largest operating cost for an LNG carrier, representing approximately one third of the total shipping costs. A one percent reduction in this BOG consumption means approximately 100k\$ per year and per

ship of savings for the charterer<sup>1</sup>. Finding operational solutions to reduce BOG is therefore a key issue for the LNG shipping industry. In this context, GTT has developed a new decision support system called "LNG Advisor Premium" which helps LNGC operators further reduce the boil-off in operation.

Through a graphical user interface, crews receive guidance as to how to optimize the overall energy consumption of the ship. Based on the vessel schedule, and taking into account the metocean forecast, LNG Advisor Premium's prediction models calculate the optimum route, speed and tank pressure, hour after hour. Guidance will be refreshed on a daily basis or more frequently on demand.

LNG Advisor Premium is based on advanced BOG prediction algorithms which account for complex phenomena such as LNG ageing or the influence of sea states on BOG generation. These models have been developed with laboratory tests on LNG behaviour and measurements on board LNGCs. For each vessel, the algorithms are calibrated and validated thanks to 400 data streams being collected every minute on the vessel.

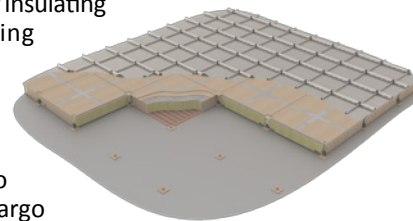
Contact: [commercial@cryometrics.com](mailto:commercial@cryometrics.com) ■

<sup>1</sup> with an LNG price of 7\$/MMBtu

## TECHNOLOGIES / Membrane CCS for LPG Carrier

GTT's Cargo Containment Systems (CCS) NO96 and Mark III have already proven their capacity to transport other gases than LNG. They are also fully compatible with LPG. However, as these technologies are designed primarily for LNG, they may not be optimized for the specific market of LPG. GTT is therefore proposing a new CCS dedicated to the transport of any liquid hydrocarbon cargo with a boiling temperature over -55°C and a liquid density lower than 700kg/m<sup>3</sup>.

This new technology, called GTT MARS™ is drawn from GTT's sea proven concepts which have been reworked in order to provide an innovative solution. The tightness of the tank is achieved by a stainless steel corrugated membrane. It is supported by a layer of insulating components consisting of plywood boxes filled with glass wool. The structure of the boxes has been designed to sustain the internal cargo pressures.



GTT MARS™ CCS design

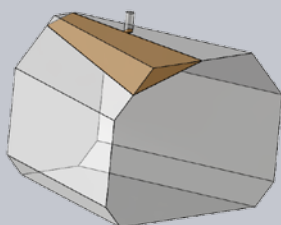
As the membrane technology is directly supported by the hull of the ship, its impact on the weight of the vessel is very limited and results in a lower lightship weight than a self-supporting tank. It is then possible to increase the total cargo capacity while staying within the same overall dimensions of the vessel.

Another key aspect of the membrane is that its heat capacity is very low. This makes it possible for the operator of the ship to optimize the cooling-down operations by up to 17 hours and to limit the volume of gas to be reliquefied. ■



## HEARS UPGRADE

HEARS, the GTT emergency assistance Hotline 24/7, expands its scope by integrating a new emergency scenario.



*Laden cargo tank under extreme static list condition*

Launched in 2013, the Hotline Emergency Assistance Response Service makes available to its clients GTT experts 24/7 to provide operational solutions and assist Operators for six scenarios including gas or liquid ingress through the primary membrane, perturbation of nitrogen regulation for insulated spaces or emergency departure with partial filling levels in the cargo tanks.

Now GTT on-duty officers are able to assist on a seventh emergency scenario related to the cargo management to help operators under abnormal vessel conditions. We have developed emergency operational procedures with associated tools to manage potential isolated vapour pockets which may form within a cargo tank in case of grounding, collision or allision resulting in excessive static list and trim conditions. This first step will allow GTT to progressively extend the offer to other unusual situations. HEARS duty officers will be trained accordingly. The new procedures will be discussed through dedicated workshops with clients in order to share onboard operational constraints.

Initially proposed to meet LNGC requirements, the HEARS staff is also working on adapting all the scenarios to FLNG and FSRU vessels, taking into account the specific operational and maintenance aspects of these platforms. ■



*Co-workshop between GTT and operators*

## APPLICATIONS / GTT membrane system, the most suitable solution for Nearshore Gravity Based Projects



GTT has continued the development of its Gravity Base Structure (GBS) concept for several applications with new partnerships. GTT technology can perfectly adapt to numerous tank configurations for these near shore or port applications.

A major construction advantage of the caisson accommodating the tanks is that they can be built in other locations than the final installation site. This is of great interest for areas which are not close to shipyards or for arctic areas where locating the construction in a mild climate zone increases efficiency and reduces CAPEX. Dedicated equipment can be provided in a yard or floating dock to enhance the construction competitiveness. After construction completion, the caisson is towed to its final location.

GTT Technologies have been developed for both LNG carriers and Concrete onshore tanks; a dedicated containment system can be obtained by combining the advantages of both designs. The GTT system is modular, and can be easily installed inside the tanks once completed while other operations are on-going resulting in an important schedule optimization compared to self-standing tanks.

GTT contributes today to several projects of GBS plants, under development, feed phase or at Call for Bid stage, metallic or concrete made, for bunkering, liquefaction or even power generation. Mature concepts are now possible via the network of relations with industrial and international construction companies, such as Sembcorp and Acciona. ■



## Mark V first ship application

The new Mark V containment system will have its first application in a new LNGC to be built by Samsung Heavy Industries and to be delivered in the second half of 2019.

This technology based on two metallic membranes (304L corrugated primary membrane and Fe-36%Ni corrugated secondary membrane) and a significantly improved guaranteed boil-off rate of 0.07%/V/day also benefits from the in-service experience of Mark III (same primary membrane and Reinforced Polyurethane Foam insulation).

This first order is the result of a strong collaboration between GTT, the shipyard and suppliers to prepare the industrialization of this new system and to demonstrate its reliability.

Leading up to this first application, a complete test and validation campaign has been performed to confirm that Mark V is fit for purpose. General Approvals have been obtained from classification societies (DNV-GL, Lloyds Register, Bureau Veritas and ABS). ■



## TECHNOLOGIES / NO96 MAX:

### From Industrialisation to Commercialisation.

Based on the current philosophy of NO96 (same Fe-36%Ni membrane and same insulation principle of plywood box filled with glass wool), NO96 MAX proposes a new bearing box structure to provide better thermal and mechanical performance. Hence, this innovative system with high performance glass wool can propose BOR of 0.09% vol/day on a classical LNG carrier, and also provides a suitable and flexible solution for new applications (such as multigas transport, Small-scale or LNG as Fuel) thanks to improved box reinforcements.

Joint Development Projects have been initiated in 2016 with both Daewoo Shipbuilding & Marine Engineering and Hudong-Zhonghua yards for the industrialization, validation and preparation of a first ship application. In particular, system prefabrication and erection have been performed conclusively through various mock-up applications. In addition, ballast and cryogenic tests have been successfully applied on a large scale mock-up in DSME. ■



Mock-up in Daewoo Shipbuilding & Marine Engineering



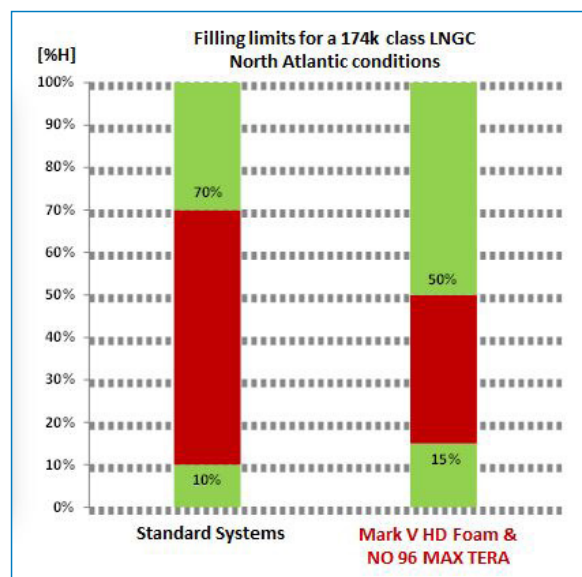
## OPERATIONS / More operational Flexibility

Through the use of High Density (HD) Foams in Mark III / Mark V and specially reinforced boxes for NO96 and NO96 MAX, GTT can now propose more flexibility in filling levels for conventional LNGCs.

The traditional filling levels in an LNGC are limited to levels above 70% of tank height or below 10% of tank height. With a limited application of these new reinforcements the upper restriction can be reduced to 60% of tank height (for standard NO96 as well as Mark III/V).

By using NO96 Max and an optimized HD foam arrangement with Mark III/V, the permitted filling levels become above 50% of tank height and below 15% of tank height. This modification is possible with, at the same time, reducing to a minimum the increase in guaranteed daily BOR.

In addition, for smaller vessels (up to 35,000 m<sup>3</sup>), a design can be proposed with no filling restrictions. ■



### Save the dates

GTT will be at **Gastech**,  
Tokyo,

**4-7 April 2017**

Please come and visit us at  
**Hall 6 - Booth 6150**

**Gastech**  
Conference & Exhibition

GTT will be at **Nor-Shipping**,  
Oslo,

**30 May - 2 June 2017**

Please come and visit us at  
**Hall D - Booth D03-24**

**NOR SHIPING**

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